

power the load. A solar source for harvesting energy is unreliable and inconvenient in that it requires outdoor use in the sun or a separate light source.

[0013] Further, certain materials (e.g., quartz and Rochelle salts, and bulk ceramic materials) are known to produce a voltage between surfaces of a solid dielectric when a mechanical stress is applied to it. This phenomenon is known as the piezoelectric effect and may be used to produce a small current as well. Conventional piezoelectric ceramic materials are typically produced in block form. These blocks of piezoelectric ceramic materials are rigid, heavy, and brittle. Bulk piezo ceramics are also expensive to produce/machine, are limited in size, and require re-enforcement or anti-fracturing structures. In addition, conventional bulk piezo ceramics typically have a relatively low output power.

[0014] Other examples of energy harvesting include hand cranked devices, such as hand cranked radios, and wind driven devices, such as windmills, and the like.

[0015] What is needed are self-powered electronic devices, systems, and methods that present a solution to at least one of the problems existing in the prior art. Further, self-powered electronic devices, systems, and methods that solve more than one or all of the disadvantages existing in the prior art while providing other advantages over the prior art would represent an advancement in the art.

#### SUMMARY

[0016] In view of the above shortcomings and drawbacks, devices, systems, and methods for self-powering portable electronic devices are provided. This technology is particularly well-suited for, but by no means limited to, self-powered portable wireless device, such as cellular telephones.

[0017] One embodiment of the present invention is directed to a self-powered, portable electronic device. The self-powered, portable electronic device includes a housing for containing electrical components and electrical circuitry associated with operation of the portable electronic device. The self-powered, portable electronic device includes one or more electrical loads. Ambient sources of mechanical energy may be associated with handling and operation of the portable electronic device. An energy harvesting system is provided comprising piezoelectric ceramic material that may be electrically coupled to one or more of the loads of the portable electronic device. The piezoelectric ceramic material energy harvesting system converts mechanical energy into electrical energy for powering one or more of the electrical loads without use of external power supplies and/or replaceable batteries.

[0018] According to another aspect of the invention, the piezoelectric ceramic material further comprises piezoelectric ceramic fibers. The piezoelectric ceramic fibers may further comprise one or more of: a piezoelectric fiber composite (PFC); a piezoelectric fiber composite bimorph (PFCB); and/or a piezoelectric multilayer composite (PMC).

[0019] According to another aspect of the invention, the piezoelectric ceramic material further comprises one or more of fibers, rods, foils, composites, and multi-layered composites.

[0020] According to one embodiment of the invention, the piezoelectric ceramic material energy harvesting system reduces a dependency of the portable electronic device on external and/or replaceable power supplies. According to another embodiment of the invention, the piezoelectric ceramic material energy harvesting system eliminates any dependency of the portable electronic device on external and/or replaceable power supplies.

[0021] According to another aspect of the invention, the one or more electrical loads further comprise low or ultra low power electronics.

[0022] According to another aspect of the invention, the piezoelectric ceramic material further comprises flexible, high charge piezoelectric ceramic fibers produced using Viscose Suspension Spinning Process (VSSP).

[0023] According to another aspect of the invention, the piezoelectric ceramic material further comprise user defined shapes and/or sizes.

[0024] According to another aspect of the invention, the piezoelectric ceramic material may be one or more of embedded within, disposed within, and/or attached to the portable electronic device.

[0025] According to another aspect of the invention, the piezoelectric ceramic material may be embedded within, disposed within, and/or attached to one or more of: the housing, a cover, a keypad, a push button, a slide button, a switch, a printed circuit board, a display screen, a ringer, a microphone, a speaker, an antenna, a holster, a carrying case, a belt, a belt clip, a stand, a stylus, and/or a mouse.

[0026] According to another aspect of the invention, the piezoelectric ceramic material may be one or more of embedded within, disposed within, and/or attached to a device or structure associated with the portable electronic device. The portable electronic device may be electrically coupled to the device or structure associated with the portable electronic device to receive a charge from the device or structure associated with the portable electronic device.

[0027] According to another aspect of the invention, the piezoelectric ceramic material generates an electrical charge in response to an applied mechanical energy input resulting from one or more of human activity and/or operation of the portable electronic device. The electric charge may be proportional to the applied mechanical energy input.

[0028] In another embodiment of the invention, an energy storage device may be provided and may be electrically coupled to the piezoelectric ceramic fibers for storing harvested energy. A rectifier may be provided to convert the energy from alternating current (AC) to direct current (DC) prior to storage in the energy storage device. The energy storage device may further comprise one of a rechargeable battery, a capacitor, and/or a super capacitor.

[0029] According to another aspect of the invention, the piezoelectric ceramic fibers may be positioned and oriented such that mechanical energy input is parallel to a longitudinal axis of the fibers.

[0030] According to another aspect of the invention, the piezoelectric ceramic fibers may be positioned and oriented having a maximum longitudinal length, wherein the maxi-